Commentary

Key advances in critical care in the out-of-hospital setting: the evolving role of laypersons and technology

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Abstract

During the past decade, critical care in the out-of-hospital setting has transcended the original emphasis on on-scene advanced life support interventions by doctors, paramedics, and nurses. Many of the life-saving efforts and advances in critical care situations have now begun to focus more and more on how, through evolving technology, the average person can save lives and perhaps even spare precious intensive care unit (ICU) resources. A striking example was the recent study conducted at the Chicago airports at which automated external defibrillators (AEDs) were deployed throughout the airline terminals for use by the public at large. Not only did random bystanders on the concourses save an extremely high percentage of cardiac arrest patients with the AEDs, most patients rapidly awakened, even before the arrival of professional rescuers. Thus, this technology-assisted intervention, performed by an average person, pre-empted the need for many other critical care interventions and prolonged care in the ICU. Equipped with automated prompts to improve performance, new technology also exists to help to monitor the inadequacies and too-frequent interruption of life-saving chest compressions during basic cardiopulmonary resuscitation. As a result of these technological advances, survival rates for cardiac arrest are now expected to improve significantly.

As we first developed intensive care units (ICUs) for our hospitals in the 1960s, we also developed our first mobile ICUs [1,2]. For some of us, our critical care practice has focused more and more on the out-of-hospital setting, and emergency medical services systems have now become our ICUs [1-3]. During the past decade, the out-of-hospital mobile ICU transcended the advanced life support practiced on-scene by paramedics, nurses, doctors, and other prehospital care providers [4,5]. As explained in the following discussion, many of the life-saving efforts and advances for critical care situations have now begun to focus increasingly on how the average person can save lives, and perhaps even spare precious ICU resources.

Many prehospital care providers have espoused the concept that 'a gram of good prehospital care can save a kilogram of in-hospital ICU care'. In the case of automated external defibrillators (AEDs), it seems that the 1,500 grams constituting the typical weight of an AED may indeed save much more than that. In fact, the technological evolution of AEDs has now also changed our traditional notions of a 'critical care practitioner'. Today's AEDs are so easy to use that even schoolchildren can operate them easily with little or no previous instruction [6]. Today, AEDs have become a standard part of basic cardiopulmonary resuscitation (CPR) training for the average person, and public access to defibrillation has become an encouraged practice, at least within certain guidelines [7-9].

The most striking testimony to the success of AEDs was the recent study conducted at the Chicago airports where AEDs were deployed throughout the airport terminals for use by the public at large [9]. It had been previously established that AEDs could be used successfully by specially targeted, specially trained 'laypersons' such as flight attendants and casino security guards [7,8]. However, this particular study was conducted specifically to determine whether the average, random bystander in the airport, with no duty to act, would retrieve the device, use it successfully, and, of course, save lives [9].

The results of this novel critical care investigation in a public setting were profound. In the first 2 years of operation, survival rates for persons collapsing with cardiac arrest in the airport concourses exceeded 75% and most of the patients were already awakening before the arrival of traditional emergency medical services units [9]. In contrast to the traditional experience with most out-of-hospital cardiac arrest

AED = automated external defibrillator; CPR = cardiopulmonary resuscitation; ICU = intensive care unit.

survivors, who typically remained in coma for significant periods [10,11], these rapidly wakening patients clearly did not experience the usual need for endotracheal intubation, mechanical ventilation, therapeutic hypothermia, and various intravenous pharmacological infusions [10,11]. Therefore, with the rapid use of AEDs by random bystanders, the usual scenario of aggressive ICU care, invasive assessments and a myriad of consultations was pre-empted for a large percentage of those patients who, traditionally, would have required them.

Even more impressive was the fact that many of the persons who had operated the AEDs for these survivors had never been trained how to use them [9]. In essence, technology has now made the average person readily capable of delivering life-saving critical care. Considering that sudden cardiac death due to ventricular fibrillation is one of the greatest causes of premature mortality in many societies, the magnitude of the public health impact of AEDs is potentially dramatic, in terms of both life-saving and ICU resources. In summary, the use of AEDs by the average person may be considered one of the greatest advances in critical care medicine during the past decade.

Similarly, recent technology has also enhanced the quality of basic CPR. For the past four decades, basic CPR has been performed by both laypersons and health professionals with significant life-saving effects [12]. However, its infrequent performance has been cited as perhaps the weakest link in the worldwide chain of survival and a key reason for low survival rates worldwide [12]. More recently, the quality of basic CPR techniques has come center-stage in resuscitation research efforts [8]. In addition to evaluating the concept of markedly abbreviating the time taken to provide effective training for the masses [13], recent investigations using sophisticated (but easy to apply) monitoring devices suggest that current CPR performance may also be inadequate in most circumstances [14,15]. However, using similar monitoring devices, the rescuers can now be prompted, during an actual CPR event, to make modifications in their techniques, and, in turn, significantly improve outcomes [8,14,15].

Specifically, there has been a renewed focus on the depth, rate, and recoil phase of chest compressions and an even stronger emphasis on not interrupting chest compressions to maintain coronary perfusion [8,14-18]. Furthermore, to avoid frequent interruptions of chest compressions, there has been a strong move to limit the rate of rescue breathing, especially in the first few minutes after sudden, unexpected collapse when oxygenation and ventilation support is of limited value [8,17,18]. In addition, the evidence has been growing steadily for deferring initial defibrillation attempts until a brief period of aggressive chest compressions can first be performed when the circulatory arrest was not witnessed by responding professional rescuers and several minutes have likely elapsed [8,19]. Evidence also strongly indicates that, in defibrillation attempts, the 'hands-off' intervals between interruption of chest compressions and the delivery of the countershock should be limited to only a few seconds [8,20]. In all of these areas of concern, evolving technology will eventually prompt the appropriate actions.

These concepts and advances in basic AED and CPR techniques have now become the cornerstone for the recently published international guidelines for CPR [8]. As a result of such guidelines and through the help of ever-evolving technology, the average person may very well become an even more effective 'critical care practitioner' over the next decade.

Competing interests

The author(s) declare that they have no competing interests.

References

1. Baskett TF, Baskett PJ: **Frank Pantridge and mobile coronary care.** *Resuscitation* 2001, **48:**99-104.
2. Cobb LA, Alvarez H, Copass MK: **A rapid response system for out-of-hospital cardiac emergencies.** *Med Clin North Am* 1976, **60:**283-290.
3. Pepe PE, Mattox KL, Duke JH, Fisher PB, Prentice FD: **Effect of full-time specialized physician supervision on the success of a large, urban emergency medical services system.** *Crit Care Med* 1993, **21:**1279-1286.
4. Pepe PE: **ACLS systems and training programs – do they make a difference?** *Respir Care* 1995, **30:**427-433.
5. Copass MK, Oreskovich MR, Bladergroen MR, Carrico CJ: **Prehospital cardiopulmonary resuscitation of the critically injured patient.** *Am J Surg* 1984, **148:**20-26.
6. Gundry JW, Comess KA, DeRook FA, Jorgenson D, Bardy GH: **Comparison of naïve sixth-grade children with trained professionals in the use of an automated external defibrillator.** *Circulation* 1999, **100:**1703-1707.
7. The Public Access Defibrillation Trial Investigators: **Public-access defibrillation and survival from out-of-hospital cardiac arrest.** *N Engl J Med* 2004, **351:**637-646.
8. American Heart Association: **The 2005 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care. Part 4. Adult basic life support.** *Circulation* 2005, **112:**19-34.
9. Caffrey SL, Willoughby PJ, Pepe PE, Becker LB: **Public use of automated external defibrillators.** *N Engl J Med* 2002, **347:** 1242-1247.
10. Hypothermia After Cardiac Arrest Study Group: **Mild therapeutic hypothermia to improve the neurological outcome after cardiac arrest.** *N Engl J Med* 2002, **346:**549-546.
11. Longstreth WT Jr, Diehr P, Inui TS: **Prediction of awakening after out-of-hospital cardiac arrest.** *N Engl J Med* 1983, **308:** 1378-1382.
12. Cummins RO, Ornato JP, Thies WH, Pepe PE: **Improving survival from sudden cardiac arrest: the 'chain of survival' concept.** *Circulation* 1991, **83:**1832-1847.
13. Roppolo LP, Ohman K, Pepe PE, Idris AH: **The effectiveness of a short cardiopulmonary resuscitation course for laypersons.** *Circulation* **112(Suppl II):**325-326.
14. Wik L, Kramer-Johansen J, Myklebust H, Sorebo H, Svensson L, Fellows B, Steen PA: **Quality of cardiopulmonary resuscitation during out-of-hospital cardiac arrest.** *JAMA* 2005, **293:**299-304.
15. Abella BS, Alvarado JP, Myklebust H, Edelson DP, Barry A, O'Hearn N, Vanden Hoek TL, Becker LB: **Quality of cardiopulmonary resuscitation after in-hospital cardiac arrest.** *JAMA* 2005, **293:**305-310.
16. Aufderheide TP, Pirrallo RG, Yannopoulos D, Klein JP, von Briesen C, Sparks CW, Deja KA, Conrad CJ, Kitshca DJ, Provo TA, Lurie KG: **Incomplete chest wall compressions: a clinical evaluation of CPR performance by EMS personnel and assessment of alternate manual chest compression-decompression techniques.** *Resuscitation* 2005, **64:**353-362.

17. Berg RA, Sanders AB, Kern KB, Hilwig RW, Heidenreich JW, Porter ME, Ewy GA: **Adverse hemodynamic effects of interrupting chest compressions for rescue breathing during cardiopulmonary resuscitation for ventricular fibrillation cardiac arrest.** *Circulation* 2001, **104:**2465-2470.
18. Roppolo LP, Pepe PE, Cimon N, Gay M, Patterson B, Yancey A, Clawson JJ: **Modified cardiopulmonary resuscitation (CPR) instruction protocols for emergency medical dispatchers; rationale and recommendations.** *Resuscitation* 2005, **65:**203-210.
19. Pepe PE, Fowler R, Roppolo L, Wigginton J: **Re-appraising the concept of immediate defibrillatory attempts for out-of-hospital ventricular fibrillation.** *Crit Care* 2004, **8:**41-45.
20. Koster RW: **Limiting 'hands-off' periods during resuscitation.** *Resuscitation* 2003, **58:**275-276.